

# **NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP) FINAL REPORT**

**PROJECT TITLE:** Geospatial Decision Support Tools for Coastal Resource Management: Vulnerability Maps Characterizing Regional Climate Variability and Change Impacts

## **Research Investigators:**

Dr. Timothy Nyerges, Professor, Department of Geography, University of Washington, Box 353550, Seattle, WA 98195, nyerges@u.washington.edu

Dr. Dawn Wright, Professor, Department of Geosciences, Oregon State University, Corvallis, OR, 97331-5506, dawn@dusk.geo.orst.edu

Dr. Robert Aguirre, Independent Scholar, Robert W. Aguirre, PLLC, 6513 Jones Ave NW, Seattle, WA 98118, aguirre@spatial-thinking.org

**NOAA GRANT NUMBER:** NA07OAR4310410

**PROJECT YEARS:** AUGUST 1, 2007 – JULY 31, 2010

## **I. PRELIMINARY MATERIALS**

### **A. Project Abstract**

This project developed, deployed and tested web-based online tools that 1) facilitate elicitation by coastal community stakeholders of concerns about vulnerability to climate change and variability, 2) assist with translation of those concerns into measurable climate condition and receptor condition indicators, and 3) present those indicators in the form of web-based online maps to support deliberation about coastal vulnerability to climate change and variability. The project tested the tools in two field experiments, each at a different spatial scale. One experiment was conducted at a regional scale for coastal Oregon. A second was a local scale for the Coos Bay National Estuarine Research Reserve (NERR) in southern Oregon.

The field experiments were conducted using two types of online workshops, one called Voicing Climate Concerns (VCC) and another called Deliberative Mapping of Vulnerability (DMV). An online workshop is conducted using structured participation techniques that guide participants through asynchronous (different time and different location) knowledge building activity. The structured participation guidance takes the form of a “participatory workflow agenda”. The asynchronous process allows participants to engage in the online activity at any time and from any place where an Internet connection is available, thereby fostering deliberative democracy for large numbers of people.

Climate and receptor condition indicators were developed during both VCC workshops, one at a regional scale and a second at a local scale. A third workshop used the DMV type of interaction. The first field experiment about vulnerability to climate change and variability at a regional Oregon coastal scale incorporated a single VCC workshop as the foundation of the

activity. A second field experiment focusing on vulnerability to climate change and variability within the Coos Bay NERR used a VCC workshop and a DMV workshop. See Appendix A. Section 5 of the Experimental Design for a description of the climate and receptor conditions used in the Coos Bay experiment.

Based on results from the first experiment, we conclude that climate change from a regional perspective does not engage community stakeholder participants sufficiently to enroll them into a deliberative discussion about climate concerns. This perspective was re-enforced through discussion with one of the Oregon coastal estuary activity coordinators who observed this first online workshop. A regional based community perspective was concluded to be too abstract for participants. Based on that conclusion, the DMV workshop was not conducted.

Based on results from the second experiment, we conclude that although students playing roles as community stakeholders in Coos Bay had little first hand knowledge of Coos Bay, they were able to articulate climate and receptor condition indicators, but were very dissatisfied with the availability of data that represent the circumstances. Several comments were made about how little regional climate data exists to support deliberation about vulnerability to climate change and variability to be considered at local scales. Special projects are needed to advance the development of regional climate information.

## **B. Objective of Research Project**

The goal of this research was to develop, deploy and test web-based tools that enable community stakeholders to articulate concerns about climate change and variability and then examine the use of those web tools within a case study experiment about climate variability and change in coastal areas of Oregon State. The web tools were to implement processes to better enable people to work with abstract information about technical topics like climate change and give them an opportunity to work with details to improve vulnerability assessment and adaptation planning. The tools are compatible with geographic information systems technology platforms.

## **C. Project Approach**

The project adopted the vulnerability assessment framework published by Füssel and Klein (2006) as the methodological framework to articulate vulnerability assessment at multiple levels. The climate concerns and vulnerability mapping sessions support level I vulnerability assessment in a direct manner only, but that did not prohibit participants from discussing level II and III issues.

Vulnerability level I : potential exposure to climate impacts

Vulnerability level II : potential exposure + sensitivity

Vulnerability level III : potential exposure + sensitivity + adaptive capacity

The terms exposure, sensitivity and adaptive capacity were defined as follows.

**Exposure:** *The nature and degree to which a system is exposed to significant climatic variations.*  
Füssel and R. J.T. Klein (2006) p.313

**Sensitivity:** *The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. [ . . . ] The effect may be direct [ . . . ] or indirect [ . . . ]* Füssel and R. J.T. Klein (2006) p. 314

**Adaptive capacity:** *The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.* Füssel and R. J.T. Klein (2006) p. 319

The project was funded to establish level I vulnerability concerns. However, a deliberative mapping web site supported discussions about sensitivity and adaptive capacity, thereby providing feedback about the development of community vulnerability indicators at levels I, II, III (and perhaps combinations of indicators that we call indexes). Establishing level I vulnerability concerns can help provide recommendations and directions for online tool building that can address more details for climate change adaptation planning.

The data to populate indicators, taking on the form of map data layers for receptor indicators and climate indicators, were assembled off-line by searching known repositories, e.g., Oregon Coastal Atlas and other sources. Receptor indicator maps and climate indicator maps were loaded into the DMV. An overlay of receptor indicator and climate indicator maps provided the basis for determining exposure of climate stimuli to receptor systems. Discussions among participants were digitally recorded using system event log technology, which stores data about all participant to server and participant to participant interactions.

An overview of the 2<sup>nd</sup> experiment that lays out the research design of the experiment and how the tools were used in the experiment is provided in Appendix A. An example of web tool screen captures from the tools is provided in Appendix B.

## References

H-M Füssel and R. J.T. Klein (2006), “Climate change vulnerability assessments: An evolution of conceptual thinking.” *Climatic Change* 75: 301-329.

## D. Description of any matching funds used for this project

A National Science Foundation (NSF) grant was awarded to Tim Nyerges (U of Washington) and Robert Aguirre to examine system event log data from the SARP experiments, in addition to processing data from a previous NSF experiment. A graduate research assistant has been employed (~\$18,000) to work with the VCC and DMV software, so we can collect human-computer-human interaction data from a second VCC experiment, which we are doing at this time. The graduate student hired on the Oregon State University portion of the SARP grant is an African-American, thus was also eligible for an Oregon Laurels Diversity Scholarship. The student was awarded this scholarship which pays for his tuition (~\$12,600). Therefore we leveraged these Oregon Laurels funds in lieu of drawing tuition money from the SARP grant.

## **II. ACCOMPLISHMENTS**

### **A. Project Tasks Accomplished**

#### **1. Voicing Climate Concerns Workshops**      November 2007 - April 2010

A web tool called Voicing Climate Concerns (VCC) was developed for this project. Much of the VCC web tool development was funded by a National Science Foundation project (2003-2008) that undertook a field experiment involving regional transportation decision making in the central Puget Sound area. The team redeveloped the workflow engine to include a participatory knowledge-building process that focuses on climate condition indicators and community receptor indicators as the basis of VCC climateconcerns.org web site. The previous project had created a Delphi structured participation tool, whereby researchers perform discussion synthesis rather than participants. This NOAA-funded rework of the web application is based upon a structured participation process called the Technology of Participation (ToP). ToP is used by fortune 5000 companies to perform strategic planning in a face-to-face setting. This is the first known use of this approach, modified to be online, within an online context. The social science outcomes are intended to compare the Delphi and the ToP based approaches, although only the latter was used in the VCC workshop.

A series of usability tests were used to assess the software. A usability test is meant to have people work with software to determine the ease of use of software, from which a team can conclude whether a software application is ready for deployment to a larger intended audience. Multiple usability tests were conducted to evaluate the way the online tools were interpreted by subjects. Participant recruitment identified approximately 25 students to take part in a usability test that exercised most of the software in November, 2008. Changes were made to the software, and the software was completed. We performed an additional usability test with members of the research team in January of 2009. Significant changes were made based on that input.

The UW team worked together with suggestions from Oregon Ocean and Coastal Management Program (OCMP) to identify stakeholder groups within Oregon that would be the potential participant pool for the Task 1 VCC Workshop and the Task 4 Deliberative Mapping of Vulnerability Workshop. The Oregon Department of Land and Conservation, and its OCMP, works with citizen involvement committees, and the team feels these committees should be among the organizations to be tapped for participation in the project. A human subjects application to the UW Internal Review Board was prepared, submitted, and approved for working with participants.

A first online VCC workshop was conducted in November 2009. The workshop resulted in outcomes that were very different than expected, based on the design of the software. Surprisingly, the usability tests did not uncover the misinterpretation of instructions. Further software redevelopment was undertaken during winter 2009 and spring 2010.

A second online VCC workshop was conducted in April 2010. Those interested in reviewing the outcomes of the 2<sup>nd</sup> VCC workshop can logon to the website (Mosaic Firefox browser is best) at <http://www.climateconcerns.org>. A website certificate warning is likely to appear since the

project is no longer paying the \$500/year certificate clearance fee, but the site is trustworthy. When the logon page appears, use "user1" (user one) as the user name and "user1" (user one) as password to see the results of the session. Click on "review" on the right side of the page. The participatory process agenda appears, and click on any link to explore the results of online activity. The experiment has ended, thus no further input will be incorporated into the knowledge building process, although it will accept your input.

## **2. Data Integration**

Nov 1 – 30, 2009; April – May 2010

Based on the results of the 1<sup>st</sup> experiment, a small number of indicators was created by far fewer participants than expected. The results were used to scan data sources for data, but data assembly was postponed based upon the conclusion that another round of software development would take place.

Experiment 2 resulted in a second set of indicators being articulated. The website instructions provided some confusion, but the outcomes were much improved. Data integration took place in April 2010. Several sources we consulted, including the Oregon Coastal Web Atlas maintained by Oregon Coastal Management Program, Oregon Climate Service, U of Washington Climate Impacts Group, and Coos Bay NERR. Despite the seeming availability of data from several organizations, there was an underwhelming amount of data for regional climate change and variability available. This lack of data was not only noted by the research team on the project, but comments from the subjects also pointed this out. The research team compiled a collection of dataset descriptors presented in Appendix A Section 5. The list was assembled from various literature, but predominantly from a 2009 report by the Oregon Coastal Management Program about *Climate Ready Communities* (Oregon Coastal Management Program 2009). [http://www.oregon.gov/ENERGY/GBLWRM/docs/climate\\_ready\\_communities.pdf](http://www.oregon.gov/ENERGY/GBLWRM/docs/climate_ready_communities.pdf). Locating data to represent the concerns in that report was a major challenge. Despite the fact that the Oregon Coastal Atlas lead was a partner on the project, the data were simply not available to be integrated into this project.

## **3. Exposure Mapping**

January - May 2010

Map data layers based on task 2 were created. Two types of data layers were to be created, a climate condition data layer and a receptor condition data layer. A climate condition data layer is a map created from a climate condition indicator elicited in Task 1 and data found in Task 2. A receptor condition data layer is a map created from a receptor data identified in Task 2. A second experiment in April 2010 identified more indicators. Data were compiled. Map data layers were created. The maps were made available to stakeholders in the 2<sup>nd</sup> online workshop enabled using another online tool developed as part of task 4.

## **4. Vulnerability Workshop**

May – June 2010

A no-cost extension allowed the team to design and implement a second online tool, one that enabled analytic-deliberative discussion among stakeholder groups. We call this 2<sup>nd</sup> tool a Deliberative Mapping of Vulnerability (DMV) Tool. In a way it is a combination of a web-based discussion forum and a web-based geographic information system (GIS) mapping tool.

The DMV accepts two types of data layers, climate condition data layers and receptor condition data layers. A receptor condition data layer combined with a climate condition data layer results in an exposure condition map. The data layer formats were created using open layer format and loaded into an open source online deliberation tool called MapChat2 (<http://mapchat.ca/>). MapChat2 was deployed as the foundation of a second type of workshop called Deliberative Mapping of Vulnerability (DMV). Those interested in reviewing the outcomes of the DMV can log on to the website at <https://pgistdev.geog.washington.edu:9008/mapchat/>. A website certificate warning is likely to appear since the project is no longer paying the \$500/year certificate clearance fee, but the site is trustworthy. Register with your own choice of user name and password. Log on with that same user name and password. Explore the software as you like.

## **5. Synthesize Collaborative Process**

May – July 2010

The team has concluded that the Drupal, a content management system currently running at Oregon State University, and now running at the University of Washington is the recommended content management system to be used for collaborative projects. There are many customizable plug-ins available for Drupal, and it is easily customizable.

Oregon Coastal Management Program, 2009. Climate Ready Communities: A Strategy for Adapting to Impacts of Climate Change on the Oregon Coast. [http://www.oregon.gov/ENERGY/GBLWRM/docs/climate\\_ready\\_communities.pdf](http://www.oregon.gov/ENERGY/GBLWRM/docs/climate_ready_communities.pdf), last accessed September 18, 2010.

## **B. Summary of Findings**

The VCC web tool was created by reworking a web tool that used a Delphi process into a web tool that implements a Technology of Participation process. Although the redesign and implementation took much longer than expected in the timeframe August 1, 2007 – September 30, 2009, the tool is more generic than expected.

Thirty participants enrolled in the workshop, far fewer than expected given the number of email addresses were able to obtain through team and partner effort. Outcomes of the workshop came in two forms. First, we conclude that climate change from a regional perspective does not engage participants sufficiently to enroll in a deliberative discussion about the topic. This perspective was re-enforced through discussion with one of the Oregon coastal estuary activity coordinators whose responsibility was of a local nature. The second outcome of the workshop was to discover that the instructions provided in the VCC web tool produced a process that was unexpected. As a result, a limited amount of indicator information was created by the experiment. That result encouraged further work with the participatory process.

For the second experiment, we cast our network a bit wider, making use of Oregon Climate Service and Oregon Coastal Web Atlas data. However, the data were still considered limited in scope to accomplish what was expected for a more local vulnerability assessment for the Coos Bay estuary. From those data the team developed data layers for both climate conditions and receptor conditions using the Open GIS data layer format for loading into a deliberative mapping tool called MapChat2. MapChat2 was a reasonable platform for use as a deliberative mapping

tool, but improvements such as clusters of climate and receptor conditions might have made the application more useful to participants.

The team synthesized aspects of collaboration for the project. The team concludes that the Drupal content management systems running at Oregon State University, and now running at the University of Washington is the content management system recommended as a collaboration platform.

### **C. Reports, papers, publications or presentations arising from this project**

Aguirre, R. and T. Nyerges, Geovisual Evaluation of Public Participation in Decision Making: The Grapevine, *Journal of Visual Languages*, accepted, to be published in 2011.

Nyerges, T., K. Belpaeme, T. Haddad, and D. Hart, Creating a Usable Atlas, in D. Wright, E. Dwyer, and V. Cummins, *Coastal Informatics: Web Atlas Design and Implementation*, IGI Publishers, pp. 256-266, 2010 (peer reviewed)

Nyerges, T., Benefits of Coastal Web Atlas Interoperability for Regional Ocean Governance, International Coastal Atlas Network Workshop, Trieste, Italy, November 17, 2009.

Nyerges, T. Participatory Decision Support Tools: Vulnerability Maps Characterizing Regional Climate Variability and Change Impacts, SARP Joint Workshop, Oregon State University, April 21, 2009

Raiford, K., in prep., 2011. The Use of GIS to Support Vulnerability Mapping of the Oregon Coast, M.S. Research Paper, Oregon State University, Corvallis, OR, <http://ir.library.oregonstate.edu/jspui/index.jsp>.

Wright, D., E. Dwyer, N. and V. Cummins, 2010. *Coastal Informatics: Web Atlas Design and Implementation*, IGI Publishers, 350 pp. (peer reviewed).

### **D. Deviations from Proposed Workplan**

In the interest of leveraging effort, the face-to-face workshop became an online workshop to take advantage of a previously developed web tool that supports online workshops. The redevelopment work was more involved than anticipated. Partnering with the Oregon Coastal Management Program (OCMP) did not result in the community stakeholder recruitment anticipated by the project team. OCMP staff explained that their community connections included professional planner staff, but not community stakeholders.

### **E. Climate information products and forecasts considered in project**

Climate information products from the U of Washington climate impacts group have been examined for suitability in the project. The regional downscaling models are not providing sufficiently extensive data for the Oregon Coast, as the focus of the Climate Impacts Group analysis is the Columbia Basin. The Oregon coastal domain is recognizably different.

Further access to data sources is needed, and thus we have been scouring the data sources within Oregon as well. Both NOAA and non-NOAA data are being considered.

Contact with other NOAA Sectoral Application Research Projects resulted in no data availability.

### **III. GRAPHICS FROM THE PROJECT**

Appendix A and B provide additional graphics from the project.

### **IV. WEBSITE ADDRESS FOR FURTHER INFORMATION**

Voicing Climate Concerns Workshop website

<http://www.climateconcerns.org>

MapChat Open Source Software website

<http://mapchat.ca/>

Deliberative Mapping of Vulnerability Research Design Document

[http://courses.washington.edu/geog360a/Climate\\_Concerns\\_n\\_Vulnerability.doc](http://courses.washington.edu/geog360a/Climate_Concerns_n_Vulnerability.doc)

Deliberative Mapping of Vulnerability Workshop website

<https://pgistdev.geog.washington.edu:9008/mapchat/>.

### **V. ADDITIONAL RELEVANT INFORMATION**

In its 2007 review of the NOAA SARP program entitled “Research and networks for decision support in the NOAA Sectoral Applications Research Program,” the National Research Council (NRC) emphasized that decision support was a two-way process of communication between the producers and the users of climate information. The NRC said that decision support is gravitating from simply providing tools and data products and towards supporting practices and processes that can engage a network of producers and users. The final program recommendations for SARP made by the NRC included the need to support research to “identify and foster the innovations needed to make information about climate variability and change more usable in specific sectors, including research on the processes that influence success or failure in the creation of knowledge-action networks for making climate information useful for decision making.”

The peer-reviewed results of our research project on the processes of decision making address two major processes influencing success or failure of climate decision support, touching on a core recommendation made by the NRC for the NOAA SARP program as a whole.

#### **Getting the Participation Right**

For over a decade, the NRC (1996, 2005, 2008) has been encouraging researchers to explore how to improve decision making about risks and vulnerabilities to public health, public safety, and the environment by advocating a best process called broadly based analytic-deliberative decision making. In terms of “getting the participation right,” our findings demonstrate the successful testing of an innovative body of geospatial online tools that can work consistently and repeatedly



to support representative and broadly-based samples of people in structured analytic-deliberative public participation situations, rather than conventional once-off public meetings or outreach.

### **Getting the Right Participation**

Our research design was to test innovative online tools using a sample of motivated participants that could be considered both geographically representative and broadly based, e.g., not limited to public planning officials but including other scientists and technical specialists, public agency decision makers, and especially, public citizen stakeholders and interested parties. We followed four different published guidelines established in the State of Oregon for citizen involvement. However, we discovered several interesting difficulties in attempting to leverage existing networks via the State of Oregon and even some conflicting overlaps with other SARP projects in terms of recruiting participants for research. Our results about “getting the right participation” suggest there are considerable challenges yet to be overcome in terms of careful research designs that include representative and broadly based samples of knowledge-action network participants engaged in structured and repeatable two-way processes of communication with NOAA climate decision makers and data specialists.

# CLIMATE CONCERNS AND VULNERABILITY: AN ONLINE EXPERIMENT VOICING CONCERNS ABOUT CLIMATE CHANGE IN A PACIFIC NORTHWEST ESTUARY

## 1. INTRODUCTION TO THE EXPERIMENT AND ITS CONCEPTS

Regardless of what might be causing climate change, assessments about community resource vulnerability are a key component of [adaptation planning for climate change and variability](#) (Füssel and Klein 2006). [Vulnerability assessments](#), as a basis for adaptation planning, combine two key pieces of information: 1) information about expected change or variability in future climate conditions, and 2) information about the properties of different receptors. The voicing climate concerns experiment will collect and synthesize concerns about the overlap (overlay) between future climate conditions and receptors in a typical Pacific Northwest estuary. Voicing concerns about how receptors might be exposed and impacted by future climate-related conditions and then translating those concerns into measurable indicators is an important part of a vulnerability assessment.

### WHAT IS VULNERABILITY?

Modeled changes in temperature, precipitation, storms, or sea-level constitute what can be measured about potential future **climate conditions**. Public input about the location, quantity, and qualities of different plants, animals, infrastructure, and communities of people constitute what is known about what people value about the properties of living and non-living **receptors**. Greater or lesser **exposure** to future change and/or variability in climate conditions usually translates into a greater or lesser **impact** on the properties of a receptor. However, the actual impact of exposure on a receptor depends on its inherent **sensitivity**. Given two receptors equally exposed to changes in climate conditions, there will be greater impact on the receptor that is more sensitive. For example, the erosive impacts of exposure to climate-induced sea-level rise and wave action will be greater on coastal property fronted by a low-lying sandy beach than coastal property fronted by a steep rocky beach.

The overall **vulnerability** of a receptor depends not only on the nature of the exposure and its inherent sensitivity, but on its **adaptive capacity**, i.e., its ability to alter its properties and reduce its exposure or its sensitivity. Given two receptors equally exposed to future climate conditions and with equal sensitivities to that exposure, the receptor that has a greater

adaptive capacity will ultimately be less vulnerable. For instance, coastal property fronted by low-lying sandy beaches under the jurisdiction of a city with greater resources available in the future to spend on shoreline improvement projects may be less vulnerable to erosive impacts than coastal property fronted by low-lying sandy beaches in rural areas. Living and non-living receptors can reduce their vulnerability in various ways in terms of their exposure, sensitivity, and adaptive capacity. Some living receptors like plants and animals might be able to adapt by migrating to a new climate, thus reducing their exposure. Some non-living receptors like community infrastructure might be modified in situ through massive public investments, thus reducing sensitivity to exposure.

## USING INDICATORS TO ASSESS VULNERABILITY

A climate indicator is simply a specific measurement of change or variability in climate conditions. Examples of climate indicators are “expected increase in average high temperature in the lower portions of the estuary itself over the next twenty years,” or “expected increase in average rainfall within the entire estuarine drainage area over the next fifty years.” A receptor indicator is a specific measurement of the properties of a phenomenon, person, place, or thing like habitats, crops, animals, etc., potentially exposed to a change in climate conditions. Examples of receptor indicators are “estuarine wetland loss in square meters per year within the South Slough reserve”, or “loss of tourism in dollars in Coos Bay.”

Indicators about receptors and climate conditions can be mapped as different layers. Map layers representing an indicator of a climate condition and a receptor can be overlaid to identify possible exposures, impacts, and vulnerability. An exposure scenario is thus the combination of a climate condition paired with a receptor as map layers. In the DMV web site, a participant can draw, label, and post their concerns about on the nature of the potential exposure based on the overlap (overlay) of map layers.

## TWO ONLINE TOOLS FOR THE EXPERIMENT

Recognizing collocation (i.e., an overlay with overlap and possible exposure) between future climate conditions and receptors at particular locations is the basis of a “level I” vulnerability assessment and is at the core of adaptation planning. A “level II” vulnerability assessment considers the impact of the overlap given the sensitivities of the receptors. A “level III” vulnerability assessment considers the adaptive capacity of the receptors, i.e., their true vulnerabilities. Even “level I” vulnerability is complex but it is made less difficult if we have tools to enable larger and more diverse groups of people to systematically work together with map-based information about climate conditions and receptors. As participants in a “level I” climate concerns and vulnerability project (CCV) experiment you will make use of two loosely coupled

web applications. The CCV experiment as a whole enables participants to work with climate change and vulnerability information in ways not previously possible.

In the first phase of the experiment, you will use a tool called [Voicing Climate Concerns \(VCC\)](#). The VCC web application is used by participants to voice concerns and develop indicators about the impact of changing climate conditions on receptors in the area around the estuary. The indicators output from VCC will be used as the basis for developing climate condition and receptor map layers, which will then be input to another application as a second phase of the experiment. The second phase of the experiment will use an application called [Deliberative Mapping of Vulnerability \(DMV\) web site](#) based on [MapChat](#). The DMV application enables participants to discuss the overlap of climate conditions and receptors using map overlay and chat tools. Visualizing the overlap of climate conditions with receptors is the basis of exposure and potential impacts.

Try to voice concerns and discuss concerns appropriate to your role by selecting and pairing up certain receptors with certain climate conditions, the combination of which we can call an “exposure scenario” (see table in **Appendix I: 36 Receptors by 4 Climate Conditions ‘Scorecard’**). Your focus is on coastal and estuarine areas associated with a [National Estuarine Research Reserve System](#) (NERR) site in the Pacific Northwest, specifically the South Slough National Estuarine Research Reserve in Coos Bay, Oregon. Please try to prepare yourself to play your role by reading the **Section 5. What you could be concerned about** below, and also referring to recent NERR participant [workshops](#) or upcoming [climate-related activities at the South Slough National Estuarine Research Reserve](#).

## ADDITIONAL INFORMATION TO BE CONSIDERED

Participants will be provided general perspectives about the decision problem. Please come to the online field experiment prepared to play a role in your activities. Any other information you find related to the situation can be used in your deliberations as well. A moderator will help guide you on a step by step basis. It is expected that you will learn how to use the online tool as we go. However, please try to confine most of your comments within the system to the actual task at hand in a role-playing capacity – rather than, for instance, discussing individual issues using the tool. There will be ample opportunity to post feedback about bugs or contact the moderator outside of the online field experiment directly to discuss individual issues.

---

## 2. ABOUT THE COOS BAY ESTUARY\*



The Coos Bay estuary is located on the Oregon coast at Coos Bay and North Bend. The estuary is approximately 13,348 acres in area and has a watershed of approximately 1,058 square miles. The Coos Bay estuary is designated as a Deep Draft Development estuary under the Oregon Estuary Classification system. The geomorphology of the area is that of a Drowned River Mouth estuary.

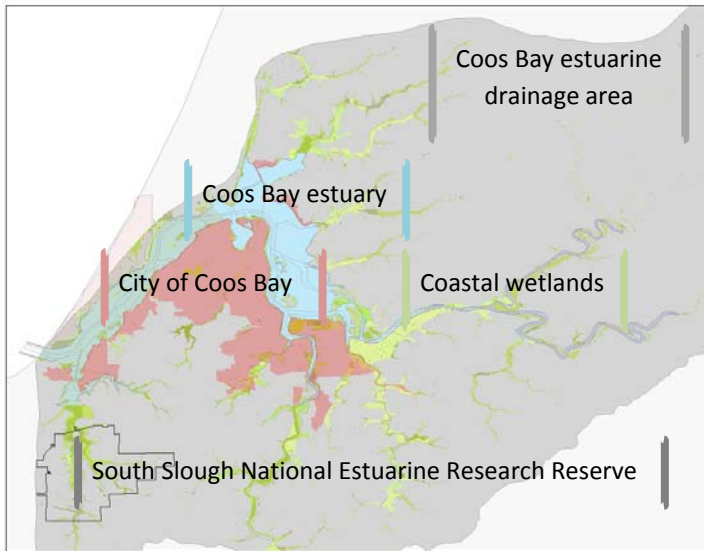
The Coos Bay estuary is located in Coos County. Timber and fishing are the foundation of the county's economy. The area also produces large quantities of shell fish. In addition vacation and recreational possibilities, such as the National Dunes Recreation Area and many state parks, attract tourists to the area and provide an additional economic stimulus. There are several port districts in the county: Port of Coos Bay founded in 1909, Port of Coquille River founded in 1912, and Port of Bandon founded in 1913. Coos Bay is considered the best natural harbor between San Francisco Bay and the Puget Sound and the Port of Coos Bay is the largest forest products shipper in world. The first census in 1860 showed a population in Coos County of 445. The 1997 population of 61,400 represented a 1.9% increase over the 1990 population.

Ride the tide up a sinuous arm of Coos Bay on a designated canoe route through the federally protected South Slough National Estuarine Research Reserve. Oystercatchers, egrets, herons, and many other birds stalk the mudflats of this estuary. The nation's first Estuarine Research Reserve was established here in 1974 on seven square miles of abandoned farmland and cut-over forest bordering Coos Bay's South Slough. Today there are 27 estuarine research reserves nationwide. Many are watching the reclamation experiments taking place at South Slough NERR to see how wildlife and plants flourish when estuary dikes are breached and upland forests allowed to re-grow. Displays in a modern interpretive center help explain the research, but the canoe route and a network of easy trails nearby allow you to investigate the reserve first hand.

\*Photo and text adapted from [http://www.coastalatlantlas.net/index.php?option=com\\_custompages&e=14&Itemid=68](http://www.coastalatlantlas.net/index.php?option=com_custompages&e=14&Itemid=68)

---

### 3. THE PROCESS RULES



In this experiment you are to consider yourself a member (see Section 4) of a diverse panel of Coos Bay executives, community representatives, and agency technical specialists tasked with creating and synthesizing a set of concerns about the impacts of regional climate change in a typical Pacific Northwest estuary, as represented by the area around the South Slough National Estuarine Research Reserve (NERR) and Coos Bay, Oregon.

The rules are that you must achieve the goal of the experiment by 1) playing your role at all times (see **Section 4. Roles to play in this experiment**), 2) working with the rest of the group to try to understand future changes in all four climate conditions (see **Section 5. What you could be concerned about**), and finally, 3) voicing concerns about the 36 receptors that you think your role would tend to value, that is be more concerned about (see **Appendix I: 36 Receptors by 4 Climate Conditions ‘Scorecard’**).

Section 4 presents roles that are available. Choose the one you are most comfortable with. Participants should be more or less equally divided among these three groups. Selection will be a first-come first-served basis and will be approved by the instructor. If a particular role has already been filled, you will have to be assigned a role to play.

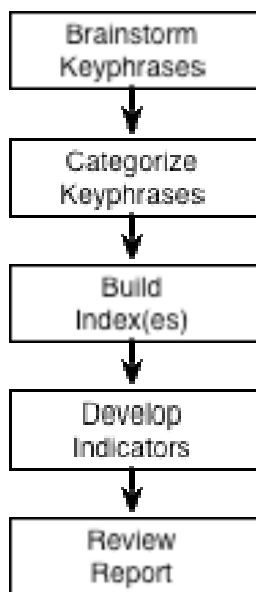
After your role has been confirmed by the instructor, you can register on the system and then login. You should choose a descriptive user name that helps others identify which of the three roles you are playing, e.g., “academic field biologist,” or “timber corporation executive.” Feel free to develop your personal profile based on a more elaborated version of the role you are playing. Whenever you are logged into the online field experiment, you are considered to be ‘in’ the role you have agreed to play.

## THE GOAL: LEVEL I VULNERABILITY ASSESSMENT

Vulnerability assessments are a key component of adaptation planning for climate change. Community vulnerability assessments provide an inventory the most salient concerns that communities might consider when undertaking adaptation planning about climate change. The goal of the online field experiment is to add and synthesize the concerns of three different groups of people (see roles below) as part of a vulnerability assessment about the regional impacts of global climate change on a particular estuary.

### PHASE 1: VOICING CLIMATE CONCERNS (VCC)

Activities in phase 1 will use the VCC tool, which includes five steps, each with a moderated discussion. An agenda is provided within the tool including detailed instructions about what to do and telling you when the step will be closed. Adopt a role (Appendix I) before you start. Playing your role, you can register, then log in at your own convenience but you must complete each step within a set time period. You must participate in every step to receive full credit. The VCC tool will allow you to add your concerns as part of your role and then translate those concerns into measurable indicators, including measurable indicators about climate conditions in general or about the exposure of particular receptors.



**Step 1.** Participants brainstorm climate concerns plus keywords/phrases for annotating concerns.

**Step 2.** Participants specify indicator labels that best represent the entire collection of keywords/phrases.

**Step 3.** Participants select indicator labels that should move forward in the process, as well as identify indicator labels that help generalize climate indicators as appropriate.

**Step 4.** Participants assign units of measurement to indicator labels, thereby suggesting ways of measuring climate conditions and receptor impacts.

**Step 5.** Participants review a report listing the indicators.

After completion of phase 1, a report will be provided to data analysts to direct their search for climate change data for the DMV web site. Throughout the 5-step process of VCC, each step includes a sub-step (a) involving individual work and a concurrent or following sub-step (b) that involves group assessment.

## PHASE 2: DELIBERATIVE MAPPING OF VULNERABILITY (DMV)

Phase 2 will take place from May 28 – June 5, 2010

The indicators developed in phase 1 suggest climate condition map layers and receptor map layers for use in phase 2. See the table [CCV Indicator Paths](#), for how that translation has occurred. DMV activities in phase 2 will use a DMV web site. The DMV web site enables participants to visualize the indicators developed by the group in phase 1 as a combination (overlay) of climate condition map layers and receptor may layers, while at the same time deliberate about exposure and vulnerability. **The [DMV MapChat](#) web site does NOT use a reserved web name domain (costs Prof. Nyerges \$500). Consequently, you will be asked to accept a web security “certificate” to approve use of the web site. This happens only once on a computer, but it is safe.**

There is NO step-wise agenda embedded within the MapChat tool. A moderator will help facilitate the process using an agenda as follows.

**Step 1.** Use role as before.

As in phase 1, you will continue to playing your role within the experiment. You must complete all steps to receive full credit - 20 extra points for undergrad and 20 graded points for grad students.

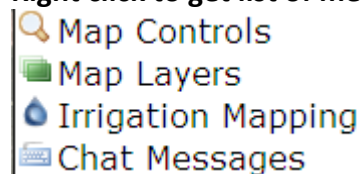
**Step 2.** Participants register in [DMV MapChat](#).

Using Mozilla Firefox browser, register an account in DMV MapChat. As early as possible, the system administrator will validate account to enable users to participate.

**Step 3.** Participants explore data and tools.

Once you are in MapChat, chose the “**DMV – Coos Bay**” under “Available Maps”. You are presented with a mapping domain wherein all layers are turned on.

**Right click to get list of menus** (see below)



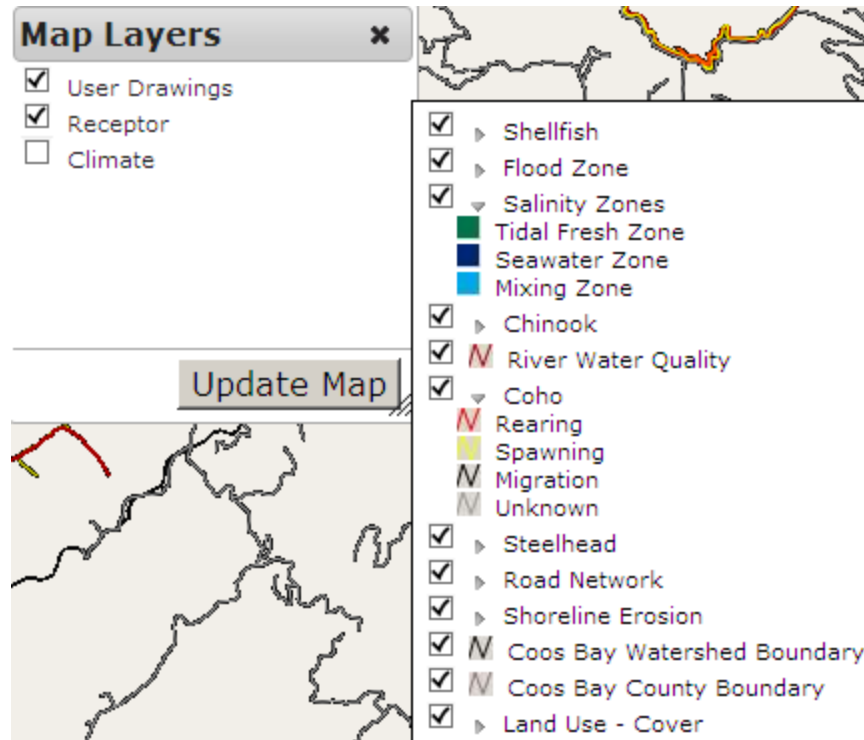
Left click on Map Layers menu to open it.



## Map Layers

Left click on “Receptor” to obtain drop down list. Note that all receptors are turned on (checked). Clicking on an “arrowhead” will turn legend on for that layer. “Green color” is the “air temp change” climate layer.

Orient yourself to the Coos Bay estuarine area map layers as you click layers and legends on an off. **\*\*\*NOTE: Use the “Map Update” button to refresh screen. DO NOT use browser refresh. If you use the browser refresh you get “kicked back” to start page.\*\*\***



Explore pairs of climate and receptor map layers, turning on one climate condition layer and/or one receptor layer at a time. Move through the layers.

## Map Controls

Next, right click on map anywhere to get the map controls. Left click on map controls to get the toolbar. Use the tools to pan, zoom, select and measure etc, as you see fit to explore the data.

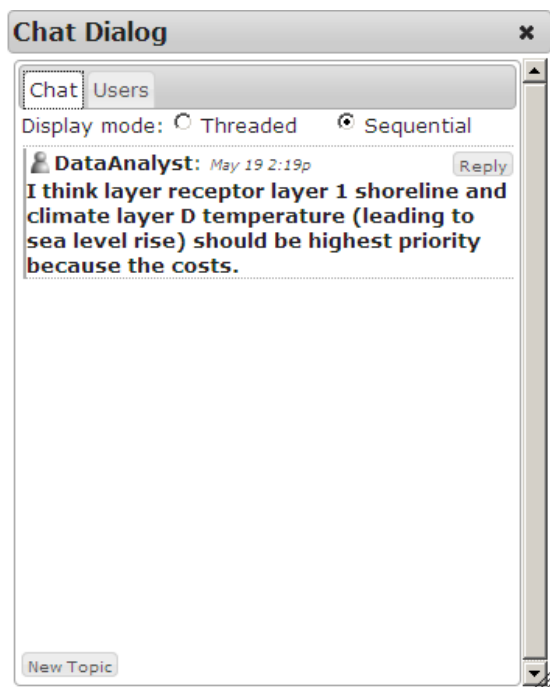


Left click on tool to activate to get:  
Pan

- Zoom in
- Zoom out
- Zoom to default
- Zoom to previous extent
- Reload map layers
- Identify feature
- Measure distance
- Measure areas
- Select feature(s)
- Draw feature(s)
- Show linked Chat Messages on Map

Next explore the Chat window by right clicking on the map anywhere. Left click on “Chat Messages”.

### Chat Messages



- Chat- window for text (deliberation)
- Users – active participants in Chat session
- Display mode
  - Threaded (linked post/reply)
  - Sequential (time stamp post/reply)

**Step 4.** Participants post comments about a pair of map layers in the text window.

Use the **New Topic** button to post a comment about a pair (climate-receptor) of map layers. Post comments describing at least five receptor layer and climate layer pairs, i.e. one receptor layer and one climate condition layer. The comments should describe the potential impacts of receptors' exposure to changing climate conditions, visualized as a spatial overlay, identifying overlap (collocation) between climate condition map layer and one receptor map layer. Participants must include in their posts **ONLY** one climate condition layer and one receptor layer to which they refer. Name of layers are provided in MapChat, some of which might appear in Appendix I: 36 Receptors by 4 Climate Conditions 'Scorecard' below.

Before you type the "return" key....consider.....if you want to spatially associate your comment.

If you want to **spatially associate your comment**, you can associate this post with a spatial extent/feature/drawing by clicking "Link to current extent, Link to Selected Features, Link to current drawing" icons below the text box.

After you spatially associate the message, then you **type return** to post the text.

**Step 5.** Participants reply.

Use the **Reply** button to post a reply to at least five other posts about the potential impacts of a receptor's exposure to changing climate conditions, by using the "reply" function in the chat tools that are within the MapChat software. These comments could agree, disagree or comment on an alternative interpretation.

When reading comments, you can click on the spatial icon "extent, feature, drawing" to display the "footprint" associated with the comment.

If you want to spatially articulate your reply, you can associate this post with a spatial extent/feature/drawing by clicking "Link to current extent, Link to Selected Features, Link to current drawing" icons below the text box.

After the completion of phase 2, the experiment is over. We hope you find the overall process insightful and productive, and hope you enjoy the experience of role-playing with others during this activity.

---

## 4. ROLES TO PLAY IN THIS EXPERIMENT

Participants are to consider the following three roles: the “executive,” the “technical specialist,” and the “community representative.” Each role is expected to have different values and will tend to focus their concerns on different types of receptors in the area around Coos Bay.

**ROLE I: THE “EXECUTIVE,”** e.g., federal, state, or local elected representative; director of a state agency department or county commissioner; port commissioner; tribal council member, or owner of a major timber or fisheries company.

The “executive” will express a wide range of concerns about likely effects of global climate change depending on who they are. Generally speaking, “executives” control resources both public and private and they decide how those resources are spent. Public agency and elected official “executives” can show a strong concern for balancing expenditure of resources across all Receptors 1, 2, and 3. Senior corporate “executives” may have strong personal concerns for coastal natural systems (Receptor 2). However, a senior “executive” of a forest products corporation probably feels strongly about the receptors in 3.3 Forestry, which sustains the health and economic well-being of their employees, while simultaneously focusing on community infrastructure Receptor 1.1 Transportation and Navigation because of its importance in conveying forest products to markets. A municipal “executive” responsible for tourism might want to balance 2.4 Coastal Shorelands with the well-being of coastal economic sectors like Receptor 3.4 Travel and Hospitality. A port commissioner “executive” would be focused on making sure than as many public resources as possible are spent on Receptor 1.1.3 Port facilities, jetties, and groins.

In general, adapting to any of the likely effects of regional climate change on the coast is an important goal for “executives” as long as doing so does not create other problems. Most “executives” believe the best approach is to balance among potentially conflicting adaptations, striving for the best long-term returns on their investments. The challenge may be in finding ways to get the most out of the dollars available to meet the wide spectrum of concerns, including joining with others to obtain more resources. Public agency or elected official “executives” want to be as inclusive of different groups as possible when they make decisions but they do not want to get bogged down.

**ROLE II: THE “TECHNICAL SPECIALIST,”** e.g., academic researcher at a nearby state university; scientist working for a state agency department; engineer working for the local port; a city planner; or a science teacher working for the local school district.

Weighing concerns in terms of scientific information and expected costs versus benefits are important responsibilities of the “technical specialist.” Depending on the “technical specialist” and what sector they work within, they could be concerned about any number of receptors. “Technical specialists” will try to answer questions and educate as many people as possible about the modeled information behind climate conditions, the state of knowledge about a certain set of receptors and their properties, or the likely impacts on different receptors to different levels of exposure to climate conditions. For instance, a wetland ecologist “technical specialist” might voice their concerns about impacts of changing climate conditions on loss of estuarine wetlands (Receptor 2.2.1) or increases in the abundance of invasive species (Receptor 2.2.4) like estuarine snails. A marine biologist “technical specialist” might be concerned about changes in the timing of seasonal ocean upwelling (Receptor 2.3.3) on sea birds and marine mammals resident in and around Coos Bay. A civil engineer “technical specialist” might try to focus attention on the sensitivities of coastal airport runways (Receptor 1.1.2) to sea level rise. On the other hand, a climatologist “technical specialist” can explain models of projected climate conditions (Conditions A, B, C or D). Finally, economists can assess what the economic impacts of Receptors 3.3.1 Forest mix, 3.3.2 Forest growth, or 3.3.3 Forest resilience might be on the timber industry in dollars over the next several decades; or the overall impacts of changing climate conditions on Receptor 3.1 Ocean Fisheries to the community’s fishing economy over the next several decades.

**ROLE III: THE “COMMUNITY REPRESENTATIVE,”** e.g., an environmental activist and local member of the group dedicated to protecting the NERR site; a small business owner in the city; a private property owner on the coast; a tribal member living on the adjacent reservation, or a frequent vacationer to the area from elsewhere in the state.

Like the “executive,” the “community representative” will express the widest range of concerns about likely effects of global climate change depending on who they are. The “community representative” feels strongly about a public process so that they understand how “executives” are using information provided by “technical specialists” when it comes to spending the public resources that they provide. To varying degrees, some “community representatives” acknowledge that spending resources protecting coastal natural systems (Receptor 2) may be difficult to balance with spending resources on their community infrastructure (Receptor 1) or economic value of the working coastal area and the region's relationship to the global economy (Receptor 3). A “community representative” might be a small business owner concerned about tourism and recreation (Receptor 3.4 Travel and Hospitality), or they might be a member of a local non-profit concerned about whether changes to estuarine wetlands (Receptor 2.2.1) in the South Slough NERR site could impact 2.5.1 Habitat distribution and composition for oystercatchers, herons, and egrets. A recently arrived retiree “community representative” might be concerned about the safety and costs of protecting their investment in their ‘dream

home' on the coast (Receptor 3.5 Growth and Development). A tribal "community representative" might be deeply concerned about public safety and the fact that their traditional tribal lands could become increasingly susceptible to floods and storm damage caused by rising sea levels (Receptor 1.2), and that the tribe simply does not have the extra public resources to spend on community infrastructure that other communities do.

**Special Note:** When choosing roles, particularly the community representatives' role, you need to be aware that under Oregon law it is the policy of the South Slough Reserve to "maintain the integrity of the estuary, protect the estuary from uses and activities, both within and beyond the boundaries, which may alter or affect the ecosystem and its natural dynamic processes, and preserve the area for long-term scientific and educational uses." At the same time, please note that you should NOT consider the reserve as a "preserve," or a park, because its primary function is as a place to conduct research about estuaries. Participants should know that the South Slough NERR is a site where experimental climate change adaptation strategies can be designed, tested and implemented, within the parameters of this policy. Research and on-the-ground experimentation is integral to our reason for being. Thus, participants should consider South Slough NERR as an asset to be used for developing climate adaptation strategies.

---

## 5. WHAT YOU COULD BE CONCERNED ABOUT

Participants are to consider the climate condition map layers and receptor layers in the context of whether you are playing the role of an "executive," a "technical specialist," or a "community representative." Some of the following information is available in the "Learn More" section of the VCC website, but no additional information is provided in MapChat. In January 2009 the Oregon Coastal Management Program, part of Oregon's Department of Land Conservation and Development, released a document entitled *Climate Ready Communities: A Strategy for Adapting to Impacts of Climate Change on the Oregon Coast* (Oregon Coastal Management Program 2009). This document includes a discussion of "The Likely Effects of Climate Change on the Oregon Coast," which is excerpted and modified below. The case study of the Coos Bay estuary will provide a representative area for voicing and synthesizing concerns on the Pacific Northwest. See also Appendix: 36 Receptors by 4 Climate Conditions 'Scorecard' below.

[N.B. Text has been modified from the original]

## **5.1 LIKELY CHANGES IN OREGON'S COASTAL CLIMATE AND WEATHER CONDITIONS**

Changes and variability in Earth's climate, driven by atmospheric warming caused by greenhouse gases, will affect the climate and weather of the Oregon coast in a variety of ways, some familiar, others dramatically new. Exactly how these changes will affect any particular community or region of the coast cannot now be accurately predicted. However, scientific evidence strongly suggests that coastal climate and weather are likely to change in four principal ways.

### **CLIMATE CONDITION A: TEMPERATURE – DATA LAYER AVAILABLE**

The current best estimate for future warming is about 0.5° F per decade, at least in the next few decades. The Pacific Northwest is projected to have greater warming during summer than in the winter. The mean temperature may increase significantly beyond current ranges over the course of the next century. A change in temperature from 2010 – 2030 is provided.

### **CLIMATE CONDITION B: STORMS – TSUNAMI\_INUNDATION**

Data show that both the frequency and intensity of storms have increased in recent years, and individual storms are producing higher waves and storm surges. Projected changes suggest that future winter storms may be similar to recent strong El Niño-influenced storms that accelerated coastal erosion. More frequent, longer and more intense storms will cause greater damage.

### **CLIMATE CONDITION C: SEA LEVEL – USGS ESTMATE**

Sea level is expected to rise significantly by 2100 but how much cannot now be predicted for any given location. Average sea level rose worldwide about 6.7 inches in the 20th century. A recent report concluded that sea level could rise on the Washington coast by 22 inches by 2050 and by 50 inches by 2100; however the data are not available to back up this statement. The most current projections do not include the effects of rapid ice melt being experienced in Greenland or Antarctica. Sea level rise will generate increased tidal heights in estuaries and coastal rivers that are affected by tides. The best available data is from USGS 2001.

### **CLIMATE CONDITION D: PRECIPITATION – DATA LAYER AVAILABLE**

Precipitation in the Pacific Northwest is expected to increase but to remain within historical ranges for rainfall. Winter precipitation is projected to increase, while summers will be longer and even drier than at present. For the Coast Range and lower elevations, precipitation will be mostly rain, as at present. Some research anticipates an increase in intense precipitation events.

## **5.2 LIKELY RECEPTORS IN COASTAL COMMUNITIES**

Climate shapes communities in many ways; some obvious, others subtle. The economy and culture of coastal communities, for instance, are tightly linked to climate. Historic precipitation patterns and generally mild temperature support the timber, agricultural, and recreational economic sectors. The effects of climate changes can be generally described, even though their magnitude, timing, and location cannot be known for certain. Anticipating both gradual change and episodic events is essential to enable communities to become resilient to effects from climate change.

### **RECEPTOR 1: COMMUNITY INFRASTRUCTURE**

Climate conditions are generally factored into the design of community infrastructure. As climate conditions change, some infrastructure systems may be less effective or may fail altogether, which could alter the function, value, or viability of improvements these systems protect or serve.

#### **RECEPTOR 1.1: TRANSPORTATION AND NAVIGATION**

*1.1.1 Coastal roads, highways, and rail lines* are at risk from the effects of increased winter precipitation, increased coastal erosion, and flooding. Over the long term, roads, highways, and railroads will be affected by sea level rise and increased tidal elevations along the ocean shore, estuaries, and coastal rivers.

*1.1.2 Airport runways* such as those in North Bend and Astoria are located on filled estuarine wetlands and may be at risk of inundation from storm surge and high tides and, over time by sea level and increased tidal heights.

*1.1.3 Port facilities, jetties and groins* will be subject to damage from larger storm waves. Watershed flooding may increase sediment loads into estuaries and thus increase the need for dredging of navigational channels. Increased tidal height will affect docks and bulkheads.

#### **RECEPTOR 1.2: SHORE PROTECTION AND FLOOD CONTROL STRUCTURES**

*1.2.1 Dikes and levees:* Extensive areas in Oregon's estuaries are protected from tidal inundation by dikes and levees. Rising sea level and the increased likelihood of inundation from higher storm surge and tidal heights, especially in times of river flooding, may threaten the integrity of dikes and levees. Infrastructure and development on lands protected by dikes are at risk of damage and inundation as dikes fail.

*1.2.2 Shore protection improvements:* Some portions of Oregon's ocean shorelines have been armored against erosion from ocean waves, primarily in front of properties developed before



1977. As shorelines erode landward in response to higher sea level and storms, armored properties are at risk of becoming peninsulas, then islands, and then overtopped. An increase in significant wave heights is likely to damage or cause failure of some hardened shorelines, potentially resulting in damage to nearby unprotected property and infrastructure.

## **RECEPTOR 1.3: MUNICIPAL SERVICES**

*1.3.1 Stormwater systems:* The capacity of local stormwater management systems may be exceeded as the magnitude or frequency of rainfall events increases, especially as tidal elevations rise leading to localized flooding, accelerated deterioration, and possible system failure. Systems at or near capacity today may be unable to handle future storm loads, which could have a significant effect on location of future development.

*1.3.2 Water supply and wastewater treatment:* Rainfall in winter is projected to increase. However, storing water across longer, drier summers may be a problem for some coastal communities where storage systems are already at or over capacity during summer. Reduced precipitation in summer months, especially in conjunction with warmer winter temperatures, may reduce the water available for municipal supply systems. In addition, wastewater treatment facilities are usually located at the lowest elevation in a watershed, which places those facilities at risk from rising sea level and tidal elevation.

*1.3.3 Recreational facilities:* Increased erosion along Oregon's ocean shore from rising sea levels and coastal storms may seriously alter beaches, and in some cases, the infrastructure necessary for safe access to and from beaches and coastal parks. Coastal forest trails and campgrounds may experience frequent damage from high winds and flooding.

## **RECEPTOR 2: COASTAL NATURAL SYSTEMS**

Many familiar coastal habitats, ecosystems, and natural resources will be affected by climate change. Low-lying habitats and ecosystems are especially vulnerable to floods, tides and ocean waves. Temperature and precipitation changes will affect the distribution and composition of forests, riparian areas, and other terrestrial habitats. Even rocky intertidal habitats are vulnerable to increased atmospheric and ocean temperatures.

### **RECEPTOR 2.1: RIVERS AND STREAMS**

*2.1.1 Coastal rivers:* Streams that drain the Coast Range will carry increased runoff from greater winter rainfall but will become drier in summer due to decreased rainfall. More severe rainfall events in these streams may increase the frequency and severity of flooding episodes. Warmer summer temperatures and lower summer stream flows may raise water temperatures to the detriment of salmon and other coldwater species.

*2.1.2 Inland rivers:* Snow melt runoff is a factor in four rivers that are important to the Oregon coast and coastal fisheries: the Columbia, Umpqua, Rogue, and Klamath. For these rivers, less snow fall and more rain may alter seasonal flow regimes, resulting in lower stream flows in late spring through the summer and fall. Changes in flow regimes may affect salmonids that are adapted to these stream systems. For the Columbia River, the presence of dams and a highly engineered hydrologic system complicate projections of impacts of climate change on the river's natural resources and ecosystems.

## RECEPTOR 2.2: ESTUARIES

Estuaries are critical and unique habitats. Estuaries reflect a balance among competing natural forces. Sustained changes in sea level, tidal elevations, river flows, or sediment loads would necessarily alter the shape and productivity of Oregon's estuaries.

*2.2.1 Estuarine wetlands* are vulnerable to rising sea level and tidal elevations, depending on rate of sediment deposition, the nature of the shoreline, and pace of sea level rise. Freshwater tidal wetlands may be inundated more frequently by saline waters, triggering changes in wetland communities. Because most Oregon estuaries are sharply bounded by steep hillsides or dikes and levees, fringe wetlands will be unable to migrate landward and will be inundated due to increased tidal elevation. An adequate supply of sediments to the estuary could enable tidal wetland elevations to keep pace with rising tidal elevation.

*2.2.2 Estuarine benthic ecosystems:* Higher air temperatures can heat mudflats and raise estuarine water temperatures, especially upstream of ocean influence, thus affecting benthic communities and productivity. The loss of benthic habitat will directly affect the composition and productivity of estuarine ecosystems.

*2.2.3 Ocean spits:* Rising sea levels and increased storminess will likely result in the long-term movement of the sand spits that form the outer boundary of many Oregon's estuaries. These forces could result in breaching of spits, as last occurred to the Tillamook spit in 1952, and which came close to occurring to the Netarts spit in 2007.

*2.2.4 Invasive species:* Estuaries in the Pacific Northwest have recently experienced biological invasions of non-native species that have had significant effects on estuarine communities. Such invasions may be related to climate factors.

*2.2.5 Acidification:* Oregon's estuaries are dominated by ocean water due to high tidal flushing twice daily. As ocean waters become more acidic, estuaries will be subjected to these same acidic conditions. The effects of increased acidity on estuarine ecosystems are not yet known, but scientists are concerned about the potential effects on clams, crabs, oysters and other shellfish.

## RECEPTOR 2.3 THE PACIFIC OCEAN

*2.3.1 Ecosystem shifts:* Summer winds are critical to upwelling that drives productivity of marine ecosystems. Recent El Niño events demonstrated that warmer ocean temperatures and shifting wind patterns can, from just one season to the next, affect upwelling and the production of phytoplankton, zooplankton, and forage fish. Seabirds, marine mammals, salmon and other species were adversely affected by El Niño conditions and are expected to be affected by long term shifts in climate conditions.

*2.3.2 Distribution of species:* Long-term changes in ocean conditions are likely to result in a northward shift in the distribution of marine species, including sea birds and marine mammals. El Niño conditions have been cited as a factor in marine mammal mortality, evidence of warm water fish in waters off Washington, and lack of seabird reproductive success.

*2.3.3 Changes in upwelling:* Timing of the seasonal upwelling in the Pacific off Oregon, which provides the nutritional foundation for the marine food web, is changing. A long-term shift in the timing of upwelling would have long-lasting effects on Oregon's commercial and recreational fisheries.

*2.3.4 Hypoxia:* While it is not clear that climate change is causing the hypoxic 'dead zones' in ocean waters off Oregon, the forces causing the hypoxia are all linked to, and affected by, climate change.

*2.3.5 Ocean acidification:* Increasing ocean acidification due to its absorption of CO<sub>2</sub> has the potential to reduce the ability of marine species to form shells, which in turn would have a dramatic effect on the entire marine food web. Shellfish such as clams, oysters, and crabs will be particularly sensitive to an increasingly acid environment.

## RECEPTOR 2.4: COASTAL SHORELANDS

*2.4.1 Ocean shore:* The ocean shore will certainly be altered in many places due to higher sea level, higher waves, more frequent and stronger storms, and possible shifts in predominant wind directions. Beach and bluff erosion will result in shoreline retreat. Ocean shores armored with rip-rap and seawalls will be increasingly at risk over time.

*2.4.2 Estuarine shores:* The shorelines of estuaries will change over time as increasing tidal elevations push the "normal" shoreline farther inland. Habitats and human uses in low-lying areas adjacent to estuaries are at risk over time even if protected by bulkheads, dikes, or levees. Habitat restoration projects in coastal shorelands should consider effects of future climate change.

## RECEPTOR 2.5: TERRESTRIAL AND AQUATIC HABITATS

*2.5.1. Habitat distribution and composition:* Terrestrial and aquatic habitats, which reflect a balance of many factors, will be affected by changes in climate. As the suitability of habitats declines, the ranges of species will likewise shift. Salmon populations, especially, are vulnerable to increased water temperatures and other climate variables throughout their life histories.

*2.5.2 Non-native species:* Habitat changes in response to shifts in temperature, salinity, and precipitation will provide opportunities for invasion by non-native species that are adapted to the new habitat conditions or that out-compete native species weakened by habitat change.

## RECEPTOR 3: COASTAL ECONOMIC SECTORS

Most of the coast's natural resource-based economic sectors are likely to be affected by changing conditions related to climate.

### RECEPTOR 3.1 OCEAN FISHERIES

*3.1.1 Salmonids:* Salmon, in particular, are highly vulnerable to changes in conditions throughout the many parts of coastal and ocean ecosystems that they occupy during their life. Expected climate-induced effects on watersheds, rivers, estuaries, and ocean ecosystems do not bode well for salmon, particularly in stream systems with already low populations.

*3.1.2 Harvest effects:* Some commercial ocean fish stock, already at low levels from overharvest, may be at risk over the long term as ocean conditions change. Changes in ocean ecosystem conditions are likely to fundamentally alter the historic fisheries of the Oregon coast.

*3.1.3 Ocean acidification:* Calcium-based plankton, which support the marine food web, are at risk from even minute changes in ocean acidity. Changes in plankton production will affect fisheries in ways that cannot now be predicted. It is not known how larger shellfish, such as clams, oysters, and crabs will fare in an increasingly acid environment.

### RECEPTOR 3.2 AGRICULTURE

*3.2.1 Water supplies:* On the south coast, water supplies needed to harvest cranberry crops may be problematic. Overall, surface water supplies from rainfall are expected to increase due to winter rains.

*3.2.2 Dikes, levees, and tidegates:* Dikes, levees, and other structures that create and protect agricultural lands around Coos Bay, Young's River, Tillamook Bay, and other estuaries and tidally-influenced rivers will be subject to higher tidal elevations and riverine flooding as sea level rises. The condition of many of these structures is not known.

## RECEPTOR 3.3 FORESTRY

*3.3.1 Forest mix:* The mix of tree species in Oregon's Coast Range Mountains and coastal lowlands is likely to change in response to changes in temperature and precipitation regimes. Broadleaf species are projected to increase in conifer forests. Forest managers may need to adjust the composition of species to be planted after harvest. Insects and disease that respond to various climate conditions will affect forest composition.

*3.3.2 Forest growth:* Warmer temperatures, increased precipitation in winter, and higher levels of CO<sub>2</sub> in the atmosphere will likely stimulate forest growth.

*3.3.3 Forest resilience:* Forests in the Coast Range, unlike forests elsewhere in the U.S., are likely to be relatively resilient to the increased winter precipitation and longer, drier summers that are projected.

*3.3.4 Fires:* Despite hotter, drier, and longer summers and an increase in woody growth and insect outbreaks, the risk of forest fires in the Coast Range is projected to remain relatively stable because of increased wet conditions during winter.

## RECEPTOR 3.4 TRAVEL AND HOSPITALITY

The Oregon coast has long been an attractive destination for tourists and for those who enjoy its many outdoor recreational opportunities and resources. Businesses in these sectors may benefit from the effects of climate change on the Oregon coast.

*3.4.1 Recreation:* Longer, drier summers may benefit Oregon's coastal recreation industries by extending the recreation season and expanding options. However, parks and recreational facilities along the ocean shore and around estuaries are likely to be affected from increased winter storms, ocean flooding, and over time, sea level rise.

*3.4.2 Tourism:* The Oregon coast may realize expanded tourist visitation because of a relatively mild and dry summer climate and extended travel season. Compared to other parts of the country, the Oregon coast may be seen as very comfortable, whether in summer or in winter, and therefore very desirable.

## RECEPTOR 3.5 GROWTH AND DEVELOPMENT

*3.5.1* Climate conditions, even though changed from historic patterns, may be relatively attractive compared to other parts of the country and therefore may attract “climate-refugees” seeking more optimum climate conditions. Coastal communities could thus experience increased in-migration, particularly retired persons, which would increase demand for residential and commercial development and demands on public facilities.

## References

H-M Füssel and R. J.T. Klein (2006), "Climate change vulnerability assessments: An evolution of conceptual thinking." *Climatic Change* 75: 301-329.

Oregon Coastal Management Program, 2009. *Climate Ready Communities: A Strategy for Adapting to Impacts of Climate Change on the Oregon Coast*.

[http://www.oregon.gov/ENERGY/GBLWRM/docs/climate\\_ready\\_communities.pdf](http://www.oregon.gov/ENERGY/GBLWRM/docs/climate_ready_communities.pdf), last accessed September 18, 2010.

#### Appendix I : 36 Receptors by 4 Climate Conditions “Scorecard”

Use the following “scorecard” below to prepare yourself for the experiment by charting out which climate condition layers and receptor layers you will likely be most concerned about given the role you choose to play. In addition, you can print out multiple copies and use this scorecard to keep track of what sorts of combinations of conditions and receptors you added to the group’s discussions in phase 1 (VCC) and phase 2 (DMV). Some of the map layers appearing in the table will not likely be available, since data was not located.

While working with the DMV web site, you will be required to specify which climate conditions and/or which receptors you are discussing. For instance, if you are concerned about temperature affecting estuarine wetlands, in the first line of your MapChat in the DMV web site you would begin your post with something like “Climate condition A, Receptor 11 ... or just simply A 11.” If you are referring to coastal natural systems in general affected by changes in precipitation, you would begin your post with something like “D 2.”

## 36 RECEPTORS BY 4 CLIMATE CONDITIONS “SCORECARD”

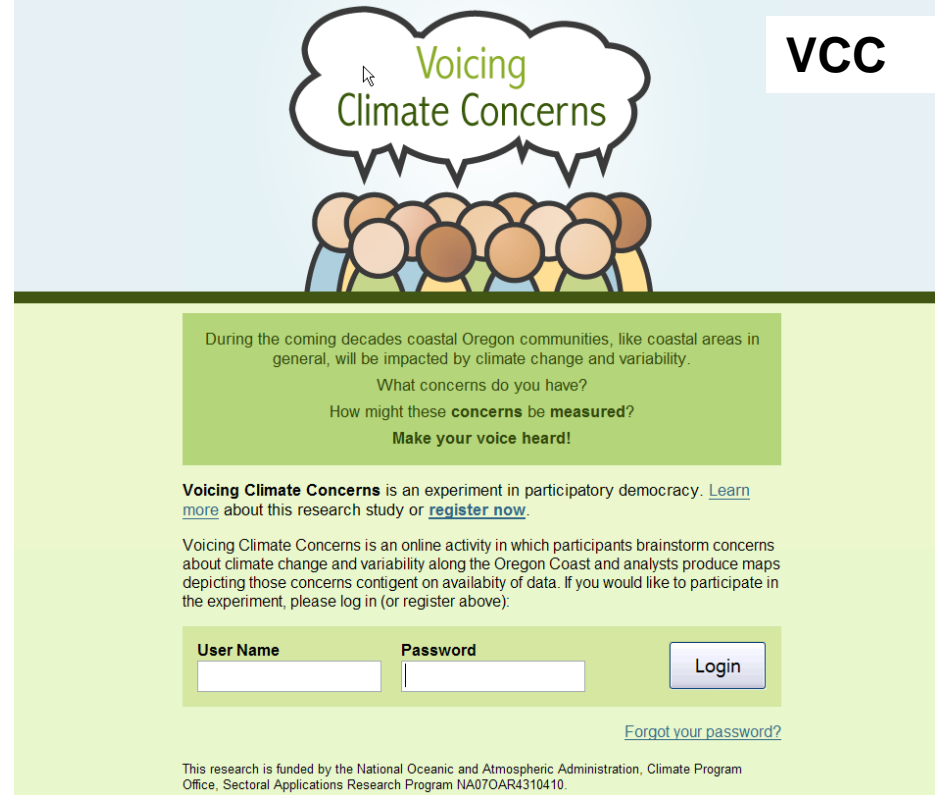
RECEPTOR	N u m		A Temperature	B Storms	C Sea Level	D Precipitation	
<b>1</b> Community Infrastructure	<b>1.1 Transportation and Navigation</b>	1	1.1.1 Coastal roads, highways, and rail lines				
		2	1.1.2 Airport runways				
		3	1.1.3 Port facilities, jetties, and groins				
	<b>1.2 Shore Protection and Flood Control Structures</b>	4	1.2.1 Dikes and levees				
		5	1.2.2 Shore protection improvements				
	<b>1.3 Municipal Services</b>	6	1.3.1 Stormwater systems				
		7	1.3.2 Water supply and wastewater treatment				
		8	1.3.3 Recreational facilities				
<b>2</b> Coastal Natural Systems	<b>2.1 Rivers and Streams</b>	9	2.1.1 Coastal rivers				
		10	2.1.2 Inland rivers				
	<b>2.2 Estuaries</b>	11	2.2.1 Estuarine wetlands				
		12	2.2.2 Estuarine benthic ecosystems				
		13	2.2.3 Ocean spits				
		14	2.2.4 Invasive species				
		15	2.2.5 Acidification				
	<b>2.3 The Pacific Ocean</b>	16	2.3.1 Ecosystem shifts				
		17	2.3.2 Distribution of species				
		18	2.3.3 Changes in upwelling				
		19	2.3.4 Hypoxia				
		20	2.3.5 Ocean acidification				
	<b>2.4 Coastal Shorelands</b>	21	2.4.1 Ocean shore				
		22	2.4.2 Estuarine shores				
	<b>2.5 Terrestrial and Aquatic Habitats</b>	23	2.5.1 Habitat distribution and composition				
24		2.5.2 Non-native species					
<b>3</b> Coastal Economic Sectors	<b>3.1 Ocean Fisheries</b>	25	3.1.1 Salmonids				
		26	3.1.2 Harvest effects				
		27	3.1.3 Ocean acidification				
	<b>3.2 Agriculture</b>	28	3.2.1 Water supplies				
		29	3.2.2 Dikes, levees, and tidegates				
	<b>3.3 Forestry</b>	30	3.3.1 Forest mix				
		31	3.3.2 Forest growth				
		32	3.3.3 Forest resilience				
		33	3.3.4 Fires				
	<b>3.4 Travel and Hospitality</b>	34	3.4.1 Recreation				
		35	3.4.2 Tourism				
<b>3.5 Growth and Development</b>	36	3.5.1 Growth and Development					



## APPENDIX B. Online Workshop Web Tools

# Voicing Climate Concerns (VCC)

## Deliberative Mapping of Vulnerability (DMV)



During the coming decades coastal Oregon communities, like coastal areas in general, will be impacted by climate change and variability.

What concerns do you have?  
How might these concerns be measured?  
Make your voice heard!

**Voicing Climate Concerns** is an experiment in participatory democracy. [Learn more](#) about this research study or [register now](#).

Voicing Climate Concerns is an online activity in which participants brainstorm concerns about climate change and variability along the Oregon Coast and analysts produce maps depicting those concerns contingent on availability of data. If you would like to participate in the experiment, please log in (or register above):

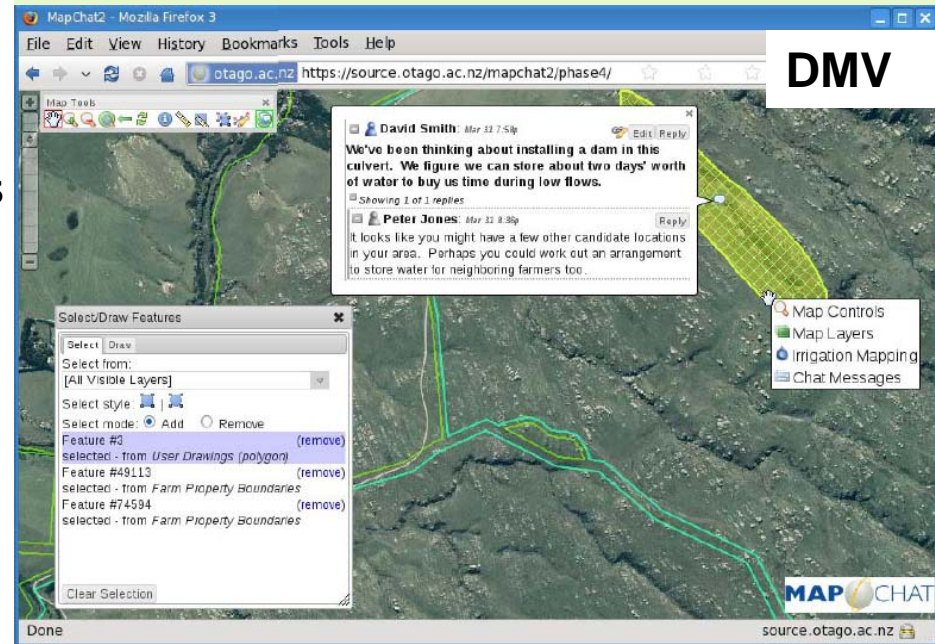
User Name:  Password:

[Forgot your password?](#)

This research is funded by the National Oceanic and Atmospheric Administration, Climate Program Office, Sectoral Applications Research Program NA07OAR4310410.

### Geospatial Decision Support Tools for Coastal Resource Management: Vulnerability Maps Characterizing Regional Climate Variability and Change Impacts August 2007 – July 2010

**Research goal:** Develop and evaluate web tools used by community stakeholders for exploring and understanding coastal climate variability and change.



MapChat2 - Mozilla Firefox 3

File Edit View History Bookmarks Tools Help

otago.ac.nz https://source.otago.ac.nz/mapchat2/phase4/

DMV

Map Controls  
Map Layers  
Irrigation Mapping  
Chat Messages

MAP CHAT

source.otago.ac.nz

Done

Select/Draw Features

Select Draw

Select from: [All Visible Layers]

Select style: [Style icons]

Select mode: Add Remove

Feature #3 selected - from User Drawings (polygon) (remove)

Feature #49113 selected - from Farm Property Boundaries (remove)

Feature #74594 selected - from Farm Property Boundaries (remove)

Clear Selection

Chat Messages

David Smith: Mar 11 7:54p  
We've been thinking about installing a dam in the culvert. We figure we can store about two days' worth of water to buy us time during low flows.

Peter Jones: Mar 11 8:30p  
It looks like you might have a few other candidate locations in your area. Perhaps you could work out an arrangement to store water for neighboring farmers too.



During the coming decades coastal Oregon communities, like coastal areas in general, will be impacted by climate change and variability.

What concerns do you have?

How might these **concerns** be **measured**?

**Make your voice heard!**

**Voicing Climate Concerns** is an experiment in participatory democracy. [Learn more](#) about this research study or [register now](#).

Voicing Climate Concerns is an online activity in which participants brainstorm concerns about climate change and variability along the Oregon Coast and analysts produce maps depicting those concerns contingent on availability of data. If you would like to participate in the experiment, please log in (or register above):

**User Name**

**Password**

Login

[Forgot your password?](#)

# VCC Online Workshop

## Voicing Climate Concerns Agenda South Slough, Coos Bay OR

Five steps are used in the process to articulate concerns, indicator labels, and units of measurement for labels.

The result is a collection of climate concern indicators for which participants wish to have a data search performed.

Once data are found, climate concern indicators are then mapped using another web tool called MapChat2. MapChat2 is used within an asynchronous online workshop called Deliberative Mapping of Vulnerability (DMV).

## Agenda

Current steps are highlighted with blue background  
Completed steps are closed for work, but open for browsing.

### **This experiment has ended.**

#### Step 1: Brainstorm and Assess Keyphrases

##### 1a: Brainstorm Keyphrases

Individuals brainstorm concern keyphrases

##### 1b: Assess Keyphrases

Review and comment on progress with group keyphrases

#### Step 2: Categorize Keyphrases and Indicator Label Progress

##### 2a. Create Indicator Labels

Individuals create indicator labels using keyphrases

##### 2b. Assess Indicator Labels

Review and comment on progress with indicator labels

#### Step 3: Endorse Indicator Labels and Assess Progress

##### 3a. Endorse Labels and Build Index(es) as Needed

Individuals select labels and build index(es) as needed

##### 3b. Assess Indicator Labels and Index(es)

Review and comment on progress with indicator labels and index(es)

#### Step 4: Develop Indicators and Assess Indicator Progress

##### 4a Develop Indicators

Individuals develop indicators using hierarchy paths

##### 4b: Assess Indicators

Review and comment on progress with group indicators

#### Step 5: Finalize Report and Assess Overall Progress

##### 5a Finalize group report

Deliberative Mapping of Vulnerability Workshop  
<https://pgistdev.geog.washington.edu:9008/mapchat>

# MAP CHAT

Username:

Password:

Login

[Register a new  
account...](#)

[Forgot your password?](#)

# MAP CHAT

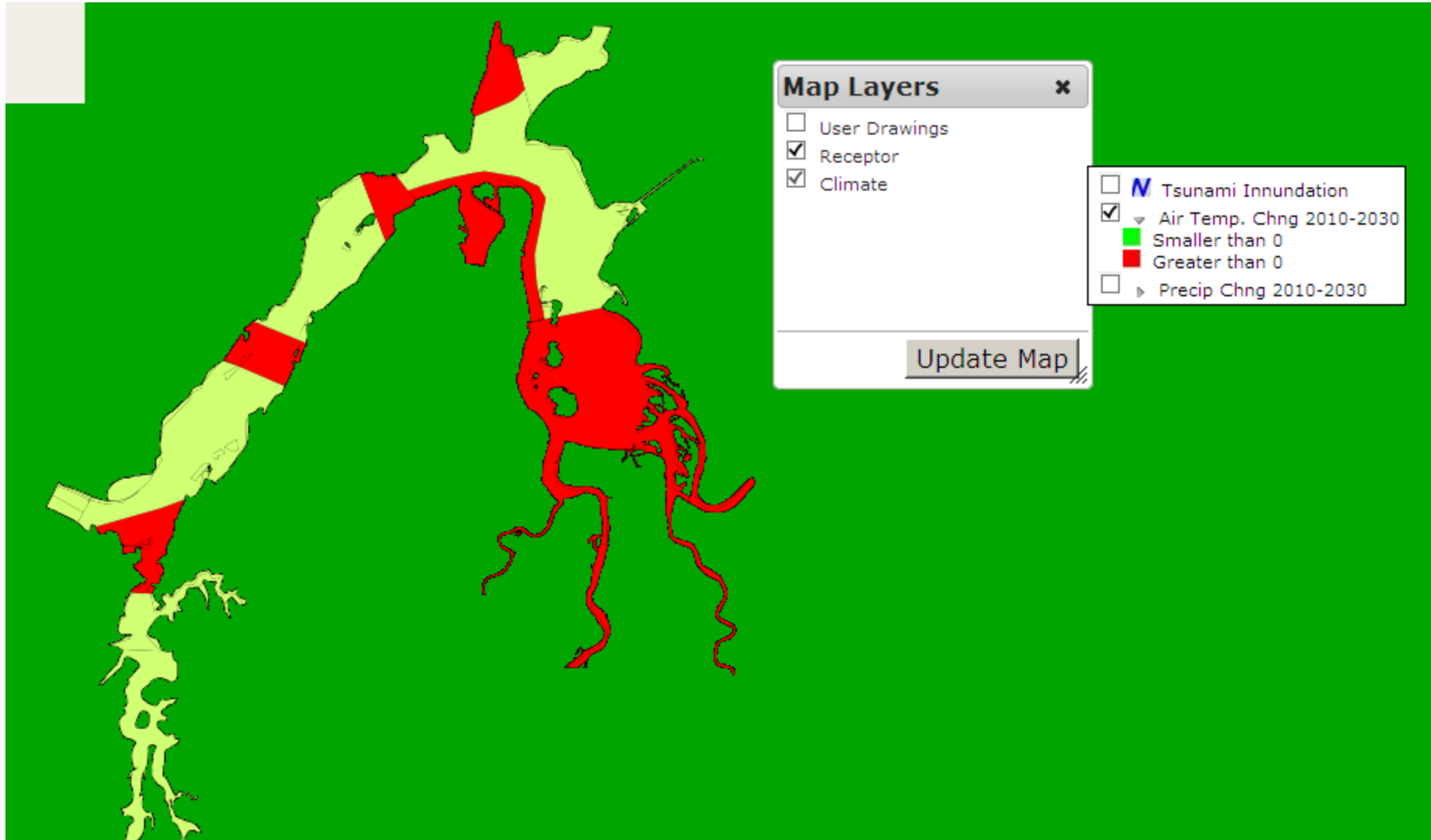
## Available Maps

- DMV - Coos Bay

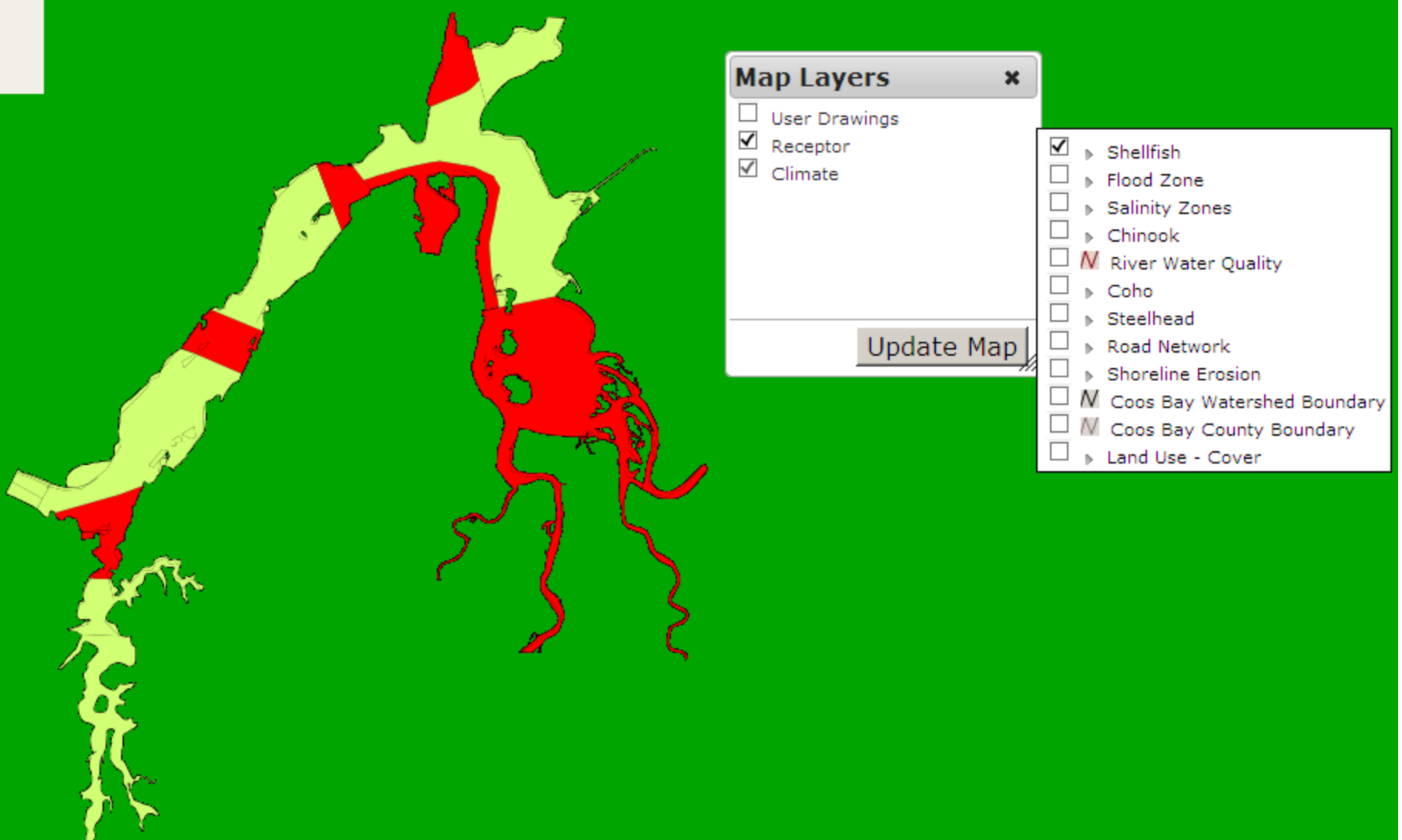
## User Options

- Edit Profile
- Change Password
- Logout

# MapChat2 climate map layer air temp change 2010 – 2030 (green)



# MapChat2 receptor map layer shellfish habitat (orange w/green)



# Chat Dialog about air temp change

The screenshot displays the MapChat2 web application interface. The main map area shows a river network with several segments highlighted in red and yellow against a green background. A 'Map Layers' panel on the right lists 'User Drawings' (unchecked), 'Receptor' (checked), and 'Climate' (checked), with an 'Update Map' button below. A 'Chat Dialog' window is open on the right, showing a conversation about air temperature changes. The chat window includes a 'Chat Users' list, a 'Display mode' selector (set to 'Sequential'), and a list of messages with 'Reply' buttons.

**Map Layers**

- User Drawings
- Receptor
- Climate

[Update Map](#)

**Chat Dialog**

Chat Users

Display mode:  Threaded  Sequential

Showing 25 of 96. Get [more](#) | [all](#)

[a key element in the temperature equation?](#)

**Lisa Utter:** Jun 09 12:06a [Reply](#)

A negative change would be a drop in temperature. This seems at odds with the theory of global warming.

**Nathaniel Lohman:** Jun 09 11:15a [Reply](#)

Also, considering that most of the Coos Bay drainage area will have decreases in rainfall of more than 1.8 mm/day 2010-2030, how will this interact with the potential tsunami wash to either provide less clean water or less debris washed off of the land. I guess that generally, it would be interesting and useful to quantify how changes in water (either precipitation or tsunami wash would affect land washed nutrient or contaminants).

**Nathaniel Lohman:** Jun 09 11:19a [Reply](#)

[Comment about Chinook spawning and](#)

[New Topic](#)

**MAP CHAT**